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Science Town 2.0: An Integrating Concept for S&T Support for Multi-Agency Crisis and Disaster Management

Anthony Masys
DRDC Centre for Security Science

Richard Hogue and Pierre Bourgouin
Environment Canada

Eugene Yee
DRDC Suffield

Jack Pagotto
DRDC Centre for Security Science

Andrew Vallerand
DRDC Centre for Security Science

Defence R&D Canada – CSS

Technical Memorandum
DRDC CSS TM 2012-029
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Canada

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Principal Author

Original signed by Anthony J Masys

Anthony J Masys

Centre for Security Science (CSS)

Approved by

Original signed by Denis Bergeron

Denis Bergeron

Centre for Security Science (CSS)

Approved for release by

Original signed by Dr. Mark Williamson

Mark Williamson

Centre for Security Science –DRP Chair

Abstract

The Vancouver 2010 Olympics (V2010) and G8/G20 summits were the largest domestic security and law enforcement mobilization operation in Canadian history. The security footprint for the Vancouver 2010 Olympics theatre of operations included over 30 secure venue locations spanning 150 kilometers and covered approximately 15,000 square kilometers thereby surpassing all previous major events in scope, scale and complexity.

To support the Vancouver 2010 Olympics and G8/G20 Major Events, unique federal Chemical, Biological, Radiological, Nuclear, Explosives and Forensics (CBRNEf) capabilities were mobilized and operationalized in support of defence and security operations through the establishment of a mobile ‘Science Town’. The success of this deployment of CBRNEf capability has precipitated the development of a Concept of Operations (CONOPS) to ensure effective and efficient mobilization of such CBRNEf S&T support in the future.

Recent national and global disasters (such as flooding, earthquakes, volcanic activity, hurricane, tsunamis and other weather phenomena) have highlighted the urgent requirement to harness and mobilize additional unique Federal S&T capabilities to support All Hazards Risk Assessment and disaster management to inform public safety and security decision making in a timely fashion. Modelling, Simulation & Analysis (MS&A) are known as crucial, effective and efficient enablers for the Defence Communities and have shown themselves as a proven capability in support of the national security domain as demonstrated through Vancouver 2010 Olympics and G8/G20 Summits (Masys and Vallerand, 2011).

Through its mandate, the Centre for Security Science (CSS) is well positioned to leverage existing, unique, credible and authoritative MS&A and mobilize it to support decision making related to all hazards scenarios such as man-made and natural disasters. Such capabilities reside across the federal government, and if mobilized and operationalized (much like the CBRNEf capabilities), they could produce a broad and profound impact to support national resilience and national confidence in the safety and security domains.

This discussion paper proposes a position to enhance the support posture vis a visa multi-agency crisis and disaster management domain through the additional mobilization of unique federal MS&A capabilities. Facilitated by CSS, the MS&A capabilities and expertise that reside within unique and horizontal ‘Clusters’ and extended ‘Communities of Practice ‘across the Federal Government can be leveraged to support risk, crisis and disaster management operations thereby formalizing a reach-back capability to support decision making, across not just the counter-terrorism domain but also the All Hazards domain.

Résumé

Les Jeux olympiques de Vancouver (V2010) ainsi que les sommets du G8 et du G20 de 2010 ont mobilisé les plus importantes forces d'application de la loi et de sécurité nationale de l'histoire du Canada. L'empreinte de la sécurité du théâtre d'opérations des Jeux olympiques de Vancouver 2010 s'est retrouvée dans plus de 30 emplacements sécurisés qui s'échelonnaient sur 150 kilomètres et couvraient environ 15 000 kilomètres carrés, surpassant ainsi tous les grands événements antérieurs en matière de portée, d'envergure et de complexité.

Dans le cadre des grands événements que sont les Jeux olympiques de Vancouver (V2010) et les sommets du G8 et du G20 de 2010, des capacités fédérales uniques relatives aux incidents chimiques, biologiques, radiologiques, nucléaires, explosifs et judiciaires (CBRNEJ) ont été mobilisées à l'appui des opérations de sécurité et de défense par la mise en place d'une « ville scientifique » mobile. La réussite du déploiement des capacités CBRNEJ a accéléré l'élaboration d'un concept d'opérations (CONOPS) visant à assurer la mobilisation efficace, à l'avenir, du soutien des S & T en matière de CBRNEJ.

De récentes catastrophes nationales et mondiales (notamment, des inondations, des tremblements de terre, de l'activité volcanique, des ouragans, des tsunamis et autres phénomènes météorologiques) ont illustré l'urgence de mettre à profit et de mobiliser des capacités fédérales uniques en matière de S & T afin d'appuyer l'évaluation tous risques et la gestion des catastrophes dans le but d'aider à la prise de décisions relatives à la sûreté et à la sécurité publiques en temps opportun. La modélisation, la simulation et l'analyse sont réputés être des outils habilitants des milieux de la Défense et se sont avérés être des capacités probantes à l'appui du domaine de la sécurité nationale, tel que démontré lors des Jeux olympiques de 2010 à Vancouver et des sommets du G8 et du G20 (Masys and Vallerand, 2011).

En vertu de son mandat, le Centre pour la sécurité des sciences (CSS) est en mesure de tirer profit d'outils existants, uniques, crédibles et spécialisés de modélisation, de simulation et d'analyse et de les mobiliser de manière à appuyer la prise de décisions relatives à tous les scénarios de risques, notamment les catastrophes causées par l'homme et les catastrophes naturelles. On trouve ces capacités à l'échelle du gouvernement fédéral. Si elles sont mobilisées et mises en service (comme dans le cas des capacités CBREFJ), elles peuvent avoir de fortes répercussions sur la résilience et la confiance nationales dans les domaines de la sûreté et de la sécurité.

Ce document de travail propose une solution visant à améliorer la posture d'appui d'un domaine de gestion de crise et de catastrophe multi organismes grâce à la mobilisation supplémentaire de capacités fédérales uniques en matière de modélisation, de simulation et d'analyse. Supervisées par le CSS, les capacités en matière de modélisation, de simulation et d'analyse et l'expertise à l'intérieur de « grappes » uniques et horizontales et de « collectivités de praticiens » élargies à l'échelle du gouvernement fédéral peuvent être utilisées pour appuyer les opérations de gestion des risques, des crises et des catastrophes, formalisant ainsi une capacité de soutien à l'appui de la prise de décisions, non seulement dans le domaine de la lutte au terrorisme, mais aussi au domaine tous risques.

Executive summary

Science Town 2.0: An integrating concept for Science Town 2.0: An Integrating Concept for S&T Support for Multi-Agency Crisis and Disaster Management:

Anthony Masys; Richard Hogue; Pierre Bourgouin; Eugene Yee; Jack Pagotto; Andrew Vallerand DRDC CSS TM 2012-029; Defence R&D Canada

Introduction or background: The Vancouver 2010 Olympics (V2010) and G8/G20 summits were the largest domestic security and law enforcement mobilization operation in Canadian history. The security footprint for the Vancouver 2010 Olympics theatre of operations included over 30 secure venue locations spanning 150 kilometers and covered approximately 15,000 square kilometers thereby surpassing all previous major events in scope, scale and complexity.

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Recent national and global disasters (such as flooding, earthquakes, volcanic activity, hurricane, tsunamis and other weather phenomena) have highlighted the urgent requirement to harness and mobilize additional unique Federal S&T capabilities to support All-Hazards Risk Assessment and disaster management to inform public safety and security decision making in a timely fashion. Modelling, Simulation & Analysis (MS&A) are known as crucial, effective and efficient enablers for the Defence Communities and have shown themselves as a proven capability in support of the national security domain as demonstrated by Vancouver 2010 Olympics and G8/G20 Summits (Masys and Vallerand, 2011).

Results: This discussion paper proposes a position to enhance the support posture vis a vis a multi-agency crisis and disaster management domain through the additional mobilization of unique federal MS&A capabilities. Facilitated by CSS, the MS&A capabilities and expertise that reside within unique and horizontal 'Clusters' and extended 'Communities of Practice' across the Federal Government can be leveraged to support risk, crisis and disaster management operations thereby formalizing a reach-back capability to support decision making, across not just the counter-terrorism domain but also the All-Hazards domain.

Significance: This discussion papers positions CSS as a key enabler in facilitating the exploitation of MS&A to support decision making in the safety and security domain.

Future plans: A workshop is planned to demonstrate the capability of mobilizing MS&A in a science town 2.0 proof of concept.

Sommaire

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Résultats : Ce document de travail propose une solution visant à améliorer la posture d'appui d'un domaine de gestion de crise et de catastrophe multi organismes grâce à la mobilisation supplémentaire de capacités fédérales uniques en matière de modélisation, de simulation et d'analyse. Supervisées par le CSS, les capacités en matière de modélisation, de simulation et d'analyse et l'expertise à l'intérieur de « grappes » uniques et horizontales et de « collectivités de praticiens » élargies à l'échelle du gouvernement fédéral peuvent être utilisées pour appuyer les opérations de gestion des risques, des crises et des catastrophes, formalisant ainsi une capacité de soutien à l'appui de la prise de décisions, non seulement dans le domaine de la lutte au terrorisme, mais aussi au domaine tous risques.

Importance : Le présent document de travail fait du CSS un catalyseur clé en ce qui a trait à l'exploitation de la modélisation, la simulation et l'analyse à l'appui de la prise de décision dans le domaine de la sûreté et de la sécurité.

Perspectives : Un atelier est prévu pour démontrer la capacité de mobiliser la modélisation, la simulation et l'analyse à l'intérieur d'une validation de concept de ville scientifique 2.0.

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1 Introduction

1.1 Context

Several disasters over the past ten years have exposed serious weaknesses in the emergency-response capabilities within the international community. With consideration of emerging and systemic risks and inherent uncertainty associated with surprising events, planning for and managing risk, crisis and disasters requires understanding of the space of possibilities in order to effectively manage disasters and catastrophes (Masys, 2012). A recent Chatham House (UK) report 'Preparing for High Impact, Low Probability Events', found that governments and businesses remain unprepared for such events (Lee, Preston and Green, 2012). As described in the Chatham House Report (Lee et al, 2012: vii), the frequency of 'high-impact, low-probability' (HILP) events in the last decade signals the emergence of a new 'normal'. Events such as 9/11, Hurricane Katrina, the Macondo oil spill and the Japanese earthquake and tsunami were all mega-disasters with global impact. But locally and equally important are the **persistent** events such as flooding, droughts, tornadoes and even pandemic outbreaks that have been shown to have equally serious impacts, raising new questions about the way in which we perceive risk and prepare for disruptive events.

Recent shocks to regional, national and global systems highlight the need to understand and plan for worst-case scenarios given the interconnected nature of our economies.
Events such as the 2010 Iceland ash cloud, the 2011 earthquake and tsunami in Japan and the floods in Thailand in 2011, and locally as the Quebec and Red River floods in 2011, the wild fires in Alberta in 2011 highlight how people, economies, and infrastructure can be severely affected with such prolonged and persistent events. As described in the Chatham Report (2012: viii), had the 2010 Iceland ash cloud continued for a few days longer, it would have taken at least a month for affected companies to recover. It is reported that planning by government and industry organizations for an ash-cloud event had failed to consider a timeframe of more than about three days. This certainly reflects the necessity to explore the possibility space through foresight and scenario planning (Masys, 2012) enabled by modeling, simulation and analysis (MS&A) (Masys and Vallerand, 2011).

From a Canadian context, the impact statement articulated by the Conference Board of Canada (2007) is reflective of the global impacts (Figure 1).

Greater Frequency and Impact of Natural Disasters

Data suggest that the incidence of natural disasters around the world is on the rise. Data from the last 30 years show an almost 400-per-cent increase in the number of reported natural disasters, and the number of people affected by natural disasters has followed the same pattern.

It is estimated that from 1994 to 2003, an average of 255 million people were affected by natural disasters around the world each year, resulting in an annual average of 58,000 deaths. In 2003, one person in 25 was affected by a natural disaster.

The increase in frequency comes at a time when the cost per disaster may also be rising, due to population growth, increased development in disaster-prone areas and an increase in material costs. The average annual economic costs from 1994 to 2003 are estimated at approximately US$67 billion per year. Historical data suggest a 14-fold increase in the economic costs of disasters since the 1950s.

To put that in a Canadian context, the direct economic damages due to natural disasters in Canada from 1974 to 2003 averaged approximately US$567 million per year. In recent history, we have seen severe storms pound Canada's east coast, freezing rain bring major urban centres to a stop and forest fires force the evacuation of an estimated 50,000 people in British Columbia.

UN/ISDR and the Centre for Research on the Epidemiology of Disasters, *2006 disasters in numbers*.

Figure 1: Impact statistics for Canada (Conference Board Report, 2007: 2)

The Defence R&D Canada – Centre for Security Science (DRDC CSS) plays an integral role in coordinating, through its unique and horizontal partnerships and program, timely and relevant science and technology (S&T) activities in support of an all-hazards approach to address terrorism, criminal activities, and accidental and natural disasters. The Centre partners with the S&T and public security community—industry, academia, federal, and provincial performers, as well as local practitioners and responders—to produce new knowledge and enhance capability. Public safety and security S&T coordinated through DRDC CSS is a Government of Canada imperative to improve the protection of critical infrastructure and emergency preparedness and response for both man-made and natural disasters.

There is a great deal of S&T work in the national interest that is conducted by the federal government itself. Federal S&T and related activities, including long-term monitoring to observe, understand, and predict trends, helps the government respond to infectious disease outbreaks, prepare for potential natural disasters, protect water supplies, manage fisheries, respond to environmental emergencies, and support public safety, security, and defence (Mobilizing S&T to Canada's Advantage, 2007:40). In particular, the federal S&T community has a resident expertise and capability to inform decision-making regarding disaster management through all phases of the disaster management cycle (from policy formulation to mitigation through to disaster recovery operations).

The position of this paper is that CSS, through its mandate, is extremely well postured to mobilize federal MS&A in a "Science Town 2.0" construct, to further support the national resilience and confidence agenda not only in Counter Terrorism related scenarios but in All-Hazards scenarios.

1.2 All-Hazards approach to Homeland Security Operations

With an increase in terrorist and naturally occurring extreme events and the rapid, globalized spread of infectious diseases and other safety and security threats, the Government of Canada is committed to being more vigilant in protecting Canadians at home and abroad. To support this, an All-Hazards Risk Assessment Methodology (Public Safety Canada, 2012) will help identify, analyze and prioritize the full range of potential non-malicious and malicious threats. The process takes into account vulnerabilities associated with specific threats, identifies potential consequences should a threat be realized, and considers means to mitigate the risks.

The all hazards risk taxonomy (figure 2), characterizes the national perspective.

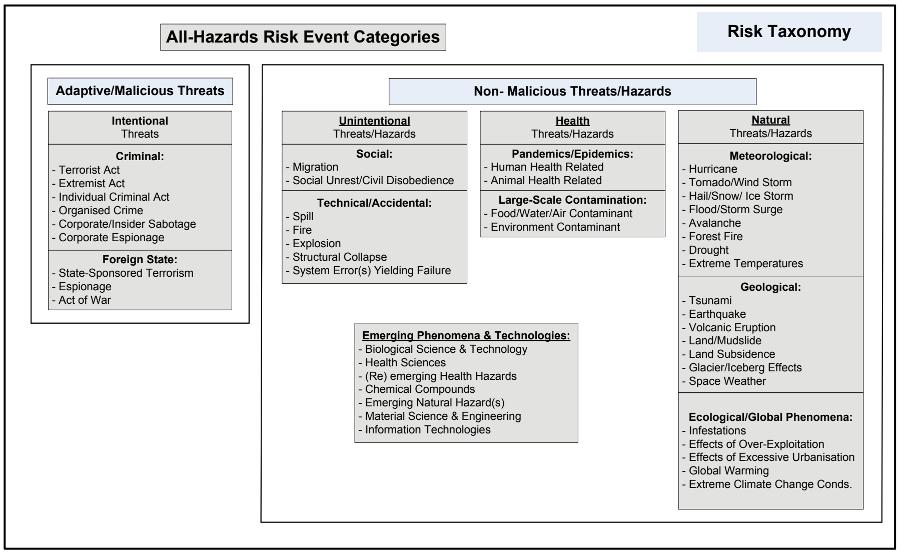


Figure 2: All Hazards Risk Taxonomy

In Canada, emergency management adopts an all-hazards approach to address both natural and human-induced hazards and disasters. We have seen a trend that indicates a noted increase in both number and frequency of disasters both nationally and globally (figure 3). These natural and human-induced hazards and disasters have become more prevalent in urban and rural communities thereby having significant impact on the social domain (Emergency Management Framework for Canada, 2011).

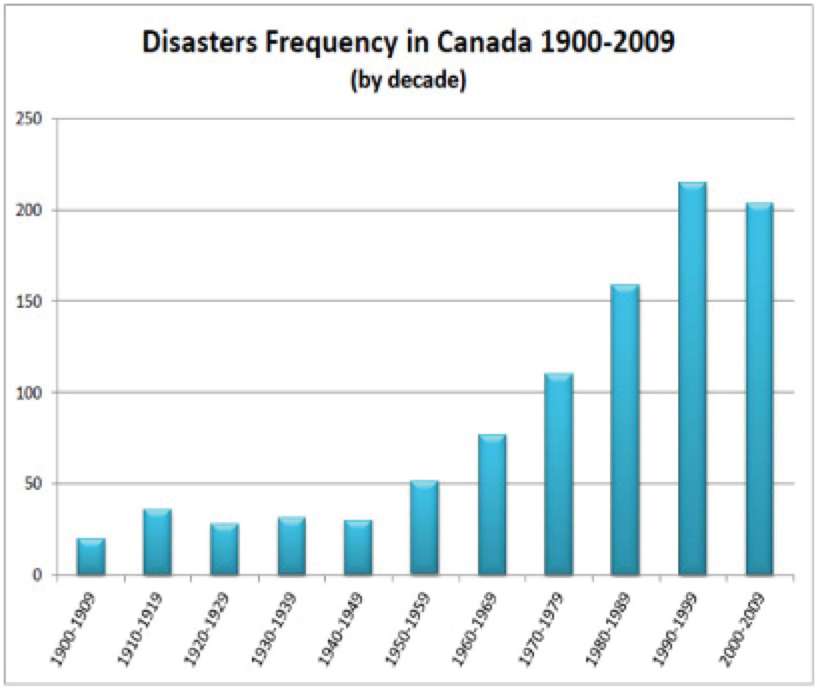


Figure 3: Disaster Frequency in Canada 1990-2009

Traditionally, emergency management in Canada has focused on preparedness and response. It is now recognized that addressing the modern 'hazardscape' requires all levels of governments to deal with specific risks, hazards and vulnerabilities through prevention and mitigation as well as recovery measures. Greater attention or investment in prevention and mitigation can prevent disasters or significantly reduce the social, economic and environmental costs and damages when events occur. Forward looking recovery measures allow communities not only to recover from recent disaster events, but also to build greater resiliency in order to help overcome past vulnerabilities. Without timely and effective foresight and decision making support, inadequate understanding and management of risks can produce extreme adverse consequences for society, communities, organizations or individuals. A good example to illustrate the importance of timely and effective modeling-based foresight is the recent SARS (H1N1) pandemic. Such modeling enabled the forecasting of the disruptions and the economic costs of such a pandemic (Loose et al, 2010), to advise decision makers accordingly.

Man-made disasters that concern emergency management include intentional events such as terrorist or cyber-attacks. They also include electrical power outages or other disruptions to a critical infrastructure sector (for example, finance, water supply and telecommunications) that result from a human or technological accident or failure as well as accidents involving socio-technical systems (such as the Deepwater Horizon accident (2010), Exxon Valdez (1989)). In addition, biological hazards, for example animal or human health diseases that risk causing a pandemic influenza (see above), concern emergency management in Canada. By assessing the risks associated with all hazards in an integrated way, efforts may be broadly effective in

reducing the vulnerability of people, property, the environment and the economy (Emergency Management Framework for Canada, 2011).

All emergency management activities must be based on knowledge about hazards, the likelihood of different types of disaster events, and likely impacts on the natural and built environment, households, organizations, and communities. Proactive, timely and responsive foresight and decision support can inform preparedness activities to stem the potential detrimental impacts of the hazards on health and safety, factors affecting continuity of operations and government, critical facilities and infrastructure, delivery of services, the environment and the economy. The current work of CSS and partners in supporting the critical infrastructure of key national airport operations with Architecture Framework modeling (DoDAF)-based interdependency analyses, resonates with this type of foresight and decision support (Garber, in progress). This work leverages the successful St Pancreas modeling conducted in the UK that used similar modeling approach (Masys and Vallerand, 2011).

The mobilization of Science Town, describing the totality of Chemical, Biological, Radiological, Nuclear, Explosive, Forensic CBRNEf science and technology (S&T) support to security operations for the Vancouver 2010 Olympic and Paralympic Games (V2010) represents the instantiation of in-situ science to inform foresight and decision making. This support included a collection of Canada's mobile laboratory capabilities together with the mobilization, thus leveraging of S&T Communities as well as reach-back mechanisms into the broader Government of Canada S&T community across the country. This innovative concept was developed by the federal S&T community through the Chemical, Biological, Radiological-Nuclear and Explosives (CBRNE) Research and Technology Initiative (CRTI) and the Major Events Coordinated Security Solutions (MECSS) project.

‘Science Town 1.0’ provides effective and efficient CBRNEf S&T mobilization to Counter Terrorism scenarios in National Security. We are proposing that scenarios related to hazards such as tsunamis, wild fires, floods, hurricanes , earthquakes, could receive more S&T attention and thus, decision makers and ultimately Canadians would benefit far more with the extended mobilization of a ‘Science Town 2.0’ as it would support a broader range of issues and threats as well as an all hazards national mitigation strategy through the advent of foresight, insight and decision support enabled through MS&A.

2 Solutions to close the All Hazards capability Gaps

2.1 MS&A and Complexity

MS&A has improved our understanding of complex problems. It has provided concepts and ideas around which both old and new insights have been organized to provide alternative theories for change, and greater understanding of underlying processes (Masys and Vallerand, 2011). Those charged with implementing policies and disaster management programmes in the face of complexity need these MS&A toolset to inform decision-making.

M&S in support of All-Hazard scenarios is especially useful for these purposes, and they could make important contributions at the strategic, operational and tactical level, and not just for the Police, Fire and Emergency Medical Responders, but also for the Emergency Operations Centre (EOC), Search & Rescue and CBRNEf communities. At the largest scale, simulations can reveal the vulnerability of whole infrastructures—and of networks of infrastructures (transportation, power, water…). As well, scenario analysis (Masys, 2012) facilitates insights into possible outcomes of management and policy strategies. On smaller scales, modeling and simulation are important tools that can provide useful perspectives on how chemical plumes, radioactive fallout, or spore clouds might disperse through the air and how hazardous material spills, such as oil and other chemicals, might spread over land or in water, how flood mitigation strategies can stay the rising water. Modeling can help examine how diseases would spread for a range of different incubation periods and transmission dynamics, as well as take into account key variables like climate, population, and migration. Understanding most-likely as well as worst-case circumstances is essential. Modeling and simulation can also be invaluable in disaster planning and training, allowing for principal players and staff to rehearse emergency procedures and gain experience in decision making under crisis conditions. Many of these models and simulations already exist within the federal S&T community. The on-going issue with the numerous debris from the Japan Tsunami travelling across the Pacific Ocean offers a good example of the opportunity for the federal S&T community to coordinate and apply M&S approaches to guide mitigation and risk assessment.

Similar to the mobilization of Science Town (Masys and Vallerand, 2011) for V2010 and G8/G20 summits, a 'Science Town 2.0" would include a much improved reach-back real-time M&S capability that would be mobilized operationally. Within this context, MS&A are useful tools to explore and make decisions about disaster management issues which leverage more authoritative knowledge. Of particular importance is their ability to be used within a participatory process, to enable multi-stakeholder knowledge access and collaboration creating a network enabled MS&A capability to support 24-7 operations. Used this way, the Science Town 2.0 through the advent of MS&A can (a) provide a flexible modeling environment ensuring ease of access to guidance and assessment in interoperable data formats, (b) allow other variables such as socio-economic impact to be explored , (c) enable a 'visualization of the problem space that is easily understood and facilitates communication between stakeholders and (d) be easily updated as new knowledge emerges thereby facilitating 'real-time', relevant support.

2.2 Federal MS&A Capability

An MS&A capability currently resides within the federal government across such domains as geological hazards, environmental and weather-related hazards, pandemic/health hazards, Cyber and CBRNEf. In building a solution, a Working Group of MS&A experts in the federal government focused on the all hazards safety and security domain can be formed to facilitate a coordinated mobilization of MS&A. The domains of M&S potentially available, for such All-Hazards scenarios include:

- **Plume M&S** for C, B, R,N, TICs, TIMs
- **Natural Disaster M&S for:**
    - Hurricane/Tornado,
    - Earthquake,
    - Tsunami,
    - Flooding,
    - Volcano
- **Fire M&S for** Wildfires
- **Emergency Mgt/Response for** Planning , CONOPS testing/validation, Interoperability testing, EOC training; Visualization
- **Architecture Framework (DoDAF) Model** for Critical Infrastructure Interdependencies as well as EOC flow of Info across Organizations.

2.3 Example of Federal MS&A Capability: Environment Canada's Meteorological Service of Canada

As one example of the MS&A capability described above, Environment Canada's Meteorological Service of Canada (EC's MSC) has been actively involved for many years in monitoring, assessing and forecasting meteorological events that are linked to natural disasters and that impact our safety, security and economy. EC's MSC has operational global capacities to monitor and forecast meteorological conditions at all time and spatial scales. It runs a highly robust 24/7 operational infrastructure which allows continuous ingestion of different types of data from across the world in order to run in real-time a wide variety of complex numerical models and simulations that play a key role in the production of forecasts for many audiences (public, marine, aviation, emergency measure organizations, provincial and federal agencies, etc.) . Forecasts and warning information on significant weather conditions are made available to uses in various dissemination channels.

EC-MSC is also actively involved in the modeling of atmospheric transport and dispersion of various hazardous materials in the atmosphere through its environmental emergency response Section in Dorval. This operational 24-7 response capacity serves several national and international mandates. This global capacity is applied to volcanic ash (VAAC Montreal), to RN agents (FNEP, FERP, WMO-RSMC, CTBTO), to man-made releases (chemical, etc.). The section also provides guidance on the transport of smoke from forest fires over Canada. In recent years, work has been extended to support CBRNE incidents with a special focus on the response to complex releases of hazardous materials in urban environments. These reach-back specialized

services are well structured to be integrated in a “Science Town 2.0” concept as was demonstrated during the Vancouver 2010 Olympics in support to Science Town.

Furthermore, significant S&T expertise in chemicals and the dispersion of various agents in the environment is found in EC’s S&T Branch, in particular in the Emergencies Science and Technology Section . That group would also play an important role to access key scientific expertise in a reach-back concept.

EC can contribute in many ways to the mobilization of M&S expertise to input in a “Science Town 2.0” concept. Other than its current many 24/7 operational functions which would support the concept directly, there are a few additional examples that are of particular interest:

- EC-MSC already produces a daily message for the GOC summarizing the most significant weather conditions in Canada that are expected in the coming days. In case of a significant natural hazard event, the meteorological conditions will be an important element to consider by the EMOs and the provincial and federal agencies. This means of communication could be leveraged further to share M&S assessment in case of an emergency situation or even in the risk assessment process.

- During the winter 2011-2012, the MSC ran a pilot project called "Early Notification 2012". The purpose of this trial was to develop an operational prototype for a basic level of service for early notification to public authorities (police, public security etc.) of high-impact meteorological events (3-7 day range). During this trial, MSC specialists were in contact with selected partners, using among other data sharing tools "MASAS"[1], where threat areas of significant weather would be identified as shown in the graphic below. The access to these kinds of operational products in interoperable formats enables the users to better address the potential impacts in their respective area, be it the impact related to significant rain or snow event, potential flooding, etc (figure 4). Furthermore, tools to assess the uncertainty associated with a given forecast have been developed in the recent years and these kinds of products would be of high interest to the user community for efficient decision making. The probability of the winds or precipitation reaching specific thresholds is key information for decision makers in their respective operations.

[1] MASAS refers to a Multi Agency Situational Awareness System, a CSS-led whole of government system, presently used by over 350 organizations to share and visualize in real time, geo-referenced Emergency Managements data and alerts (Pagotto & Allport, 2010).

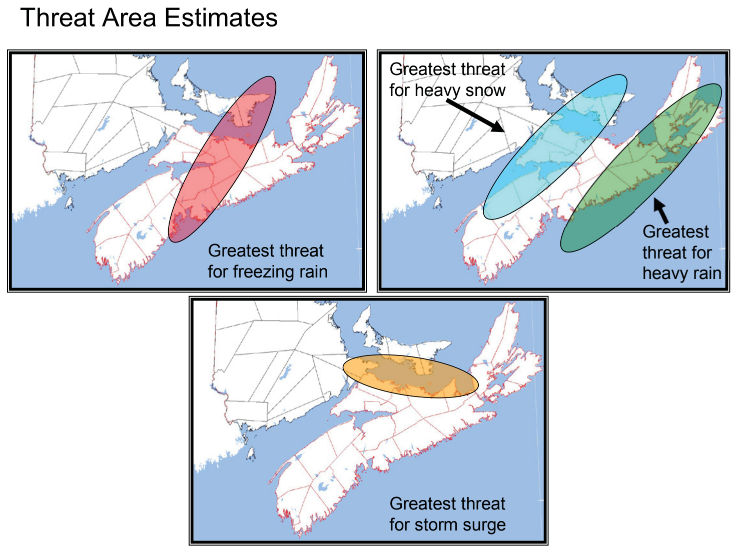


Figure 4: Operational Products to support risk management

- Along the lines of threat assessment, work is being pursued on the concept of "vigilance approach" as a mean to better communicate meteorological hazards to users. The basic components of that approach are to i) detect and forecast the event, ii) assess the potential risks, and, iii) communicate reliable, comprehensible and timely messages to key users. This vigilance approach goes beyond traditional weather alert messages and attempts to integrate the vulnerabilities and potential impacts in the messaging in order to better support decision-making. This kind of initiative would clearly fit into a "Science Town 2.0" concept. Again, the MASAS portal (figure 5) could be a good tool to share this kind of vigilance assessment.

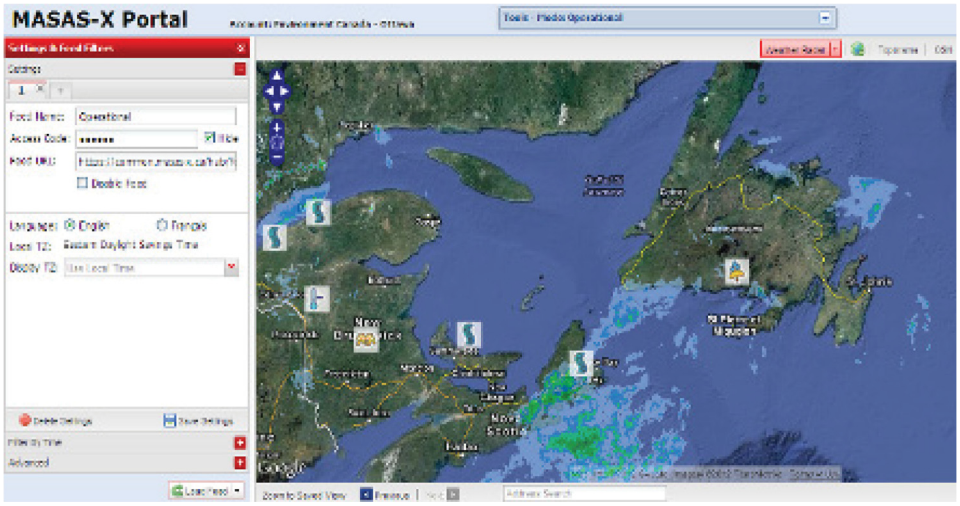


Figure 5: MASAS portal

- MSC's ability to provide operational specialized guidance on the dispersion of hazardous material in the atmosphere was well demonstrated in the context of significant events such as the Iceland volcano eruptions and the Fukushima nuclear power plant incident (see example of plume modeling below). It would be interesting to extend and leverage on that solid expertise and operational capability towards a reach-back "Science Town 2.0" concept. For instance, plume dispersion outputs could be provided in GIS format into MASAS along with pertinent information on the agent released and potential impacts. This approach would be of particular interest in assessing complex situations in the urban environments where MSC has been developing in the last 5 years with CRTI funds, high resolution capabilities to assess dispersion issues within the main Canadian cities.

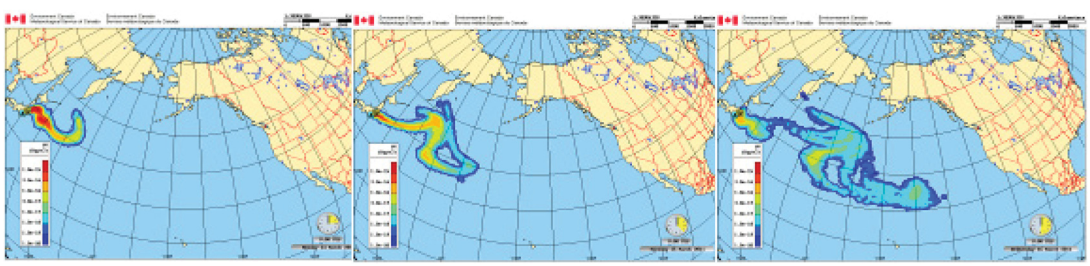


Figure 6: Dispersion modeling

- The MSC plans on implementing full 3D Ocean modeling capabilities in the coming years. This will enable a much needed capability to better address the dispersion of hazardous material in the water as well as on the surface. This will help in EC's capabilities to support not only the response to oil spills and other chemicals but as well to address specialized threats such as the release of radioactive material in the water such

as in the case of an incident with a nuclear submarine or a leakage of radioactive material from a nuclear power plant, such as in the Fukushima incident (figure 6).

We will see in the coming years a strong push towards integrated environmental modeling, integrated ocean-ice-atmosphere modeling and a push for Federal Departments to collaborate towards this vision. Common supercomputing platforms will be conducive to that collaboration and the reach-back services to M&S such as envisioned in the “Science Town 2.0” concept, and would fit in nicely with that overall vision.

2.4 MS&A Capability in CBRN

Another example of M&S operational support focuses on diffusion models in support of risk, crisis and disaster management. The environmental and toxicological impact of the downwind transport and diffusion of Chemical, Biological, Radiological, Nuclear, Toxic Industrial Chemical, Toxic Industrial Materials (C, B, R, N, TICs and TIMs) released into the atmosphere has become increasingly important in recent years. Certainly, following the September 11th 2001 terrorist attacks on the World Trade Center in New York City and the Pentagon in Washington DC, a significant MS&A R&D effort was undertaken to develop an advanced, high-fidelity, fully validated, state-of-the-science modeling system for the prediction of urban flow and dispersion of CBRN agents released in these highly disturbed flows.

Over the last several years, a quantitative C, B, R, N, TICs and TIMs hazard framework for critical asset and risk analysis that considers both accidental and deliberate releases of these materials into the atmosphere has been developed. It is anticipated that building the capacity to deal with this limited set of hazards in the form of an advanced integrative multiscale modeling system (to be described below) will increase the capacity to deal with other hazards (e.g., natural hazards such as earthquakes, forest fires, volcanic eruptions, flooding, etc.), and provide a solid foundation for the development of an all-hazards framework for actionable risk assessments. After all, all forms of hazards whether natural or human-caused, involve necessarily activities that are common for all disasters (e.g., the need for emergency warning and sheltering-in-place and/or mass evacuations; development of strategies to prevent or reduce the impact of the hazards; recovery planning to reduce social and economic impact; etc.).

In the integrative multiscale urban modeling system (Figure 7), the prediction of large-scale environmental flows is based on a comprehensive and fully-integrated global atmospheric forecasting and simulation system known by the acronym GEM LAM which refers to “the **G**lobal **E**nvironmental **M**ultiscale model which encompasses **L**ocal **A**rea **M**odeling”. As the name implies, GEM LAM is designed to model atmospheric phenomena covering a wide range of temporal and spatial scales, from the meso-γ regime involving scales of several hundred metres right through to the global scales of tens of thousands of kilometers, within one consistent and universal modeling framework.

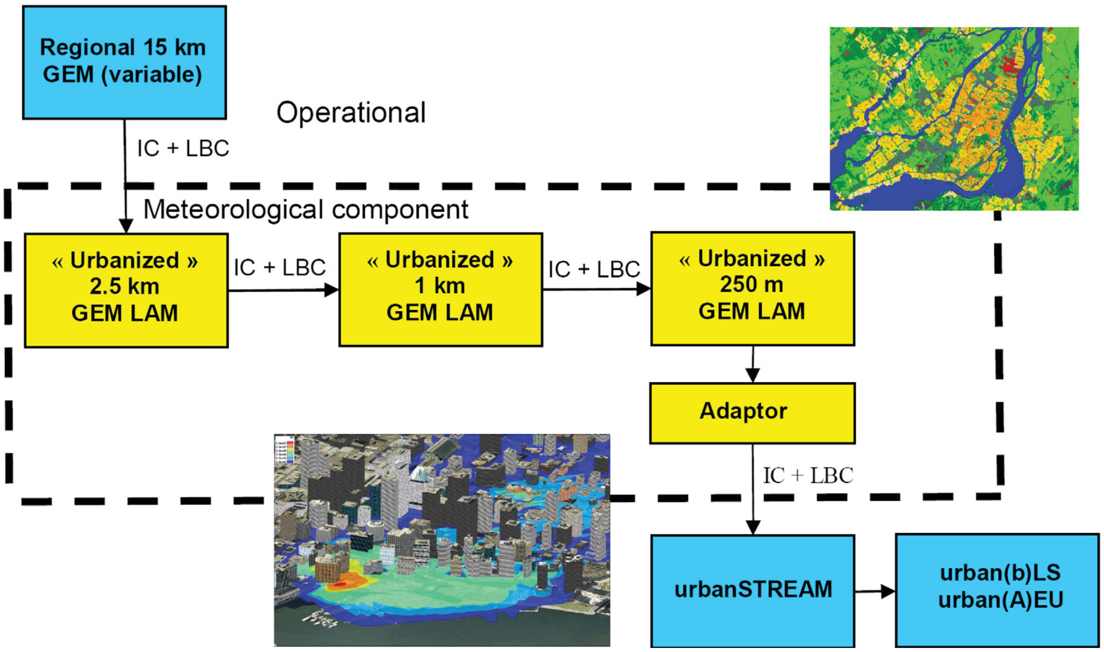
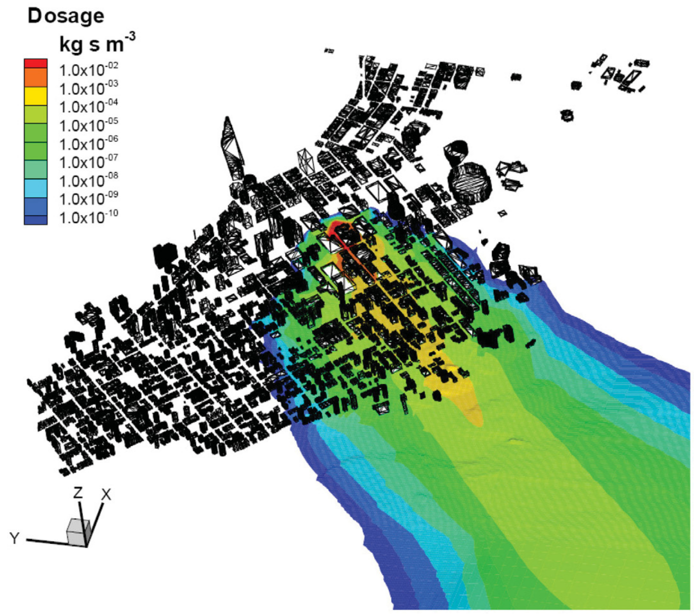


Figure 7: Integrative multiscale urban modeling system.

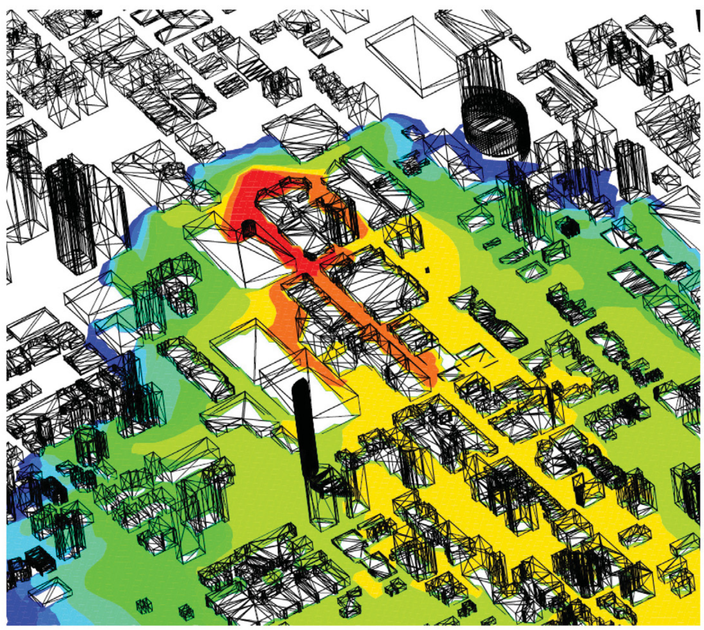
In addition to emergency response applications, products derived from this comprehensive CBRN modeling system can be used also for pre-incident planning and post-incident assessment. It is expected that these decision support products can be used: (1) for pre-planning [e.g., CBRN siting tool for pre-incident planning that produces maps showing the best (and worst) places to put a limited number of sensors around a building or other critical infrastructure based on probability of detection] and as training aids for first responders; (2) to guide forensics analysis by providing comprehensive post-event reconstruction of a purported CBRN agent release; (3) to guide the planning of safe evacuation routes; and, (4) to provide estimates of risks associated with certain courses of action and to select the most appropriate emergency response strategy. It is expected that these types of end-user products, spanning the entire spectrum of CBRN support (from planning to response to recovery) will improve the formulation of CBRN risk reduction strategies and of decisions to enhance the protection of critical infrastructure, as well as provide a common situational awareness of the emerging threat in multiple collaborating emergency operations centres at all levels of government (municipal, provincial and federal). The integrated MS&A system described here can potentially be extended from a CBRN framework to a full all-hazards framework. Indeed, it is expected that the development of such a high-fidelity, multiscale and multi-physics modeling system and its realization as a fully functional operational system in a government operations facility (or, facilities) will provide a unique real-time MS&A tool for the prediction of hazard effects required to support Canada's more broadly based efforts at advancing a quantitative all-hazards framework for planning and managing the entire spectrum of natural and human-caused hazards (e.g, Science Town 2.0 and beyond).

The modeling system described briefly above has already been used for support of major events of national and international significance [e.g., Vancouver Winter Olympic Games, Group of Eight (G8) and Twenty (G20) Summits, Francophonie Summit]. As an example of this support, building-resolved wind field libraries for Vancouver and Toronto have been constructed consisting of pre-computed building-resolved mean wind and turbulence fields obtained from a high-resolution, high-fidelity CFD model. These wind field libraries have been used for "on-demand" CFD in support of emergency response applications (requiring quick turn-around times) for the 2010 Winter Olympic Games in Vancouver and for the G8/G20 Summits in Toronto. Figure 8 shows an example of application of the wind field library for Vancouver involving the rapid calculation of the urban dispersion resulting from the (hypothetical) release of 20-kg of the nerve agent sarin (GB) disseminated from a stationary truck-mounted sprayer at a location in downtown Vancouver (near the Scotia Bank Tower). The near-surface dosage isopleths resulting from this release can be used to construct the critical toxic corridors (hazard areas) associated with this disruptive event (Yee, 2010).

There are a number of significant new capabilities that can be incorporated into the integrative modeling system to improve the current MS&A technology for provision of decision support products for first responders and emergency management commanders concerned with managing the consequences arising from hazardous releases of CBRN and/or toxic industrial materials.



(a) Large area



(b) Small area

Figure 8: Isopleths of the surface deposition density on the ground surface, as well as on the roofs and walls of the buildings for (a) a large area in the building-aware region and (b) an

expanded view over a smaller area of the building-aware region of downtown Vancouver. The results are obtained for a prevailing wind direction of 45 degrees.

One of the most serious deficiencies in current MS&A for support of an all-hazards framework (which includes CBRN hazards as a subset) is uncertainty quantification of the model predictions. As advocated herein, MS&A will play an increasing role in the future for support of critical asset and risk analysis within a quantitative all-hazards framework that will function potentially as a computational knowledge engine. However, to be effective in this role, predictive simulations provided by MS&A systems must be accompanied by reliable and defensible estimates of their level of accuracy, limits of applicability, and of the level of confidence that can be placed in such estimates. In view of this, the imperative is to seek better methods to characterize, quantify, and manage the uncertainty in all aspects of MS&A, which include input, model structural, parametric, and output uncertainties. Scientific computations for quantification, estimation and prediction of uncertainties for complex integrated MS&A systems is perhaps the key prerequisite for modern, scientifically defensible policy analysis and decision making for risk management within a quantitative all-hazards framework. This crucial challenge must be addressed properly if integrated MS&A systems are to function as trusted policy simulators to improve situational awareness and to provide actionable risk assessments within an uncertain environment of security threats (which involve the usual known unknowns, as well a "fog" of unknown unknowns).

2.5 Visualization of MS&A

MASAS, the Multi Agency Situational Awareness System led by CSS and used by over 350 organizations to date, is a very good example of a visualization tool that supports practitioners and decision makers with the ingestion of data, the analysis of such data and their evaluation leading to more evidence-based decisions and actions from prevention and preparedness to response and recovery.

This whole of government MASAS system is presently used by many organizations to share in real time, geo-referenced Emergency Managements data and alerts using a user-friendly web-based system designed smartly and efficiently around an open architecture and open standards. It is thus an optimal capability to share the result of relevant MS&A and visualize it on a common system for the related authoritative community who needs to be aware (Pagotto & Allport, 2010) As shown by the screen capture (figure 9), it can rapidly help the sharing of data as well as the outputs of modeling related to many of the hazards scenarios described earlier.

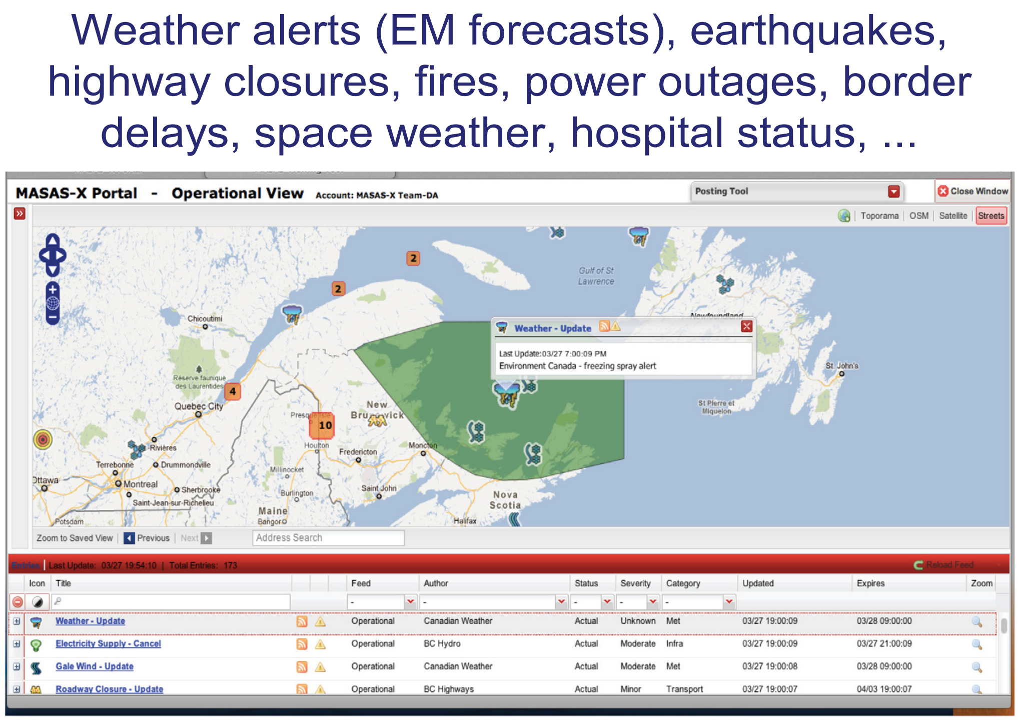


Figure 9: Alerts and Emergency Management forecasts, visualized and shared though MASAS

In addition to the common MS&A tools, there is another series of tools that can be immensely powerful to decision makers and they are referred to as Visual analytics tools. Such analytical tools have transformed not only how we visualize complex and dynamic phenomena in today's new information age, but also how we may optimize analytical reasoning and make sound decisions with incomplete and uncertain information, not at all an unusual situation during the management of crisis and emergencies.

Visual analytics tools address challenges involving analytical reasoning, data representations and transformations, visual representations and interaction techniques, and techniques to support production, presentation, and dissemination of results. Therefore, Visual analytics is especially concerned with sense-making and reasoning and strongly supports problem solving and decision making. Broad categories of tools include text analytics, video analytics, geo-temporal analytics, broadcast and web monitoring analytics, social network analytics, situational awareness, multi-dimensional linked views/dimensions for results/data characterization and correlation. Ultimately, such analyses support discovery, foresight, insight, prototyping, and decision making. Figure 10 shows some examples of the tools categories above. Several organizations in Government, Industry, Academia and Allies have significant capabilities in Visual Analytics (Wright & Gratton, 2011; Lavigne & Gouin, 2011).

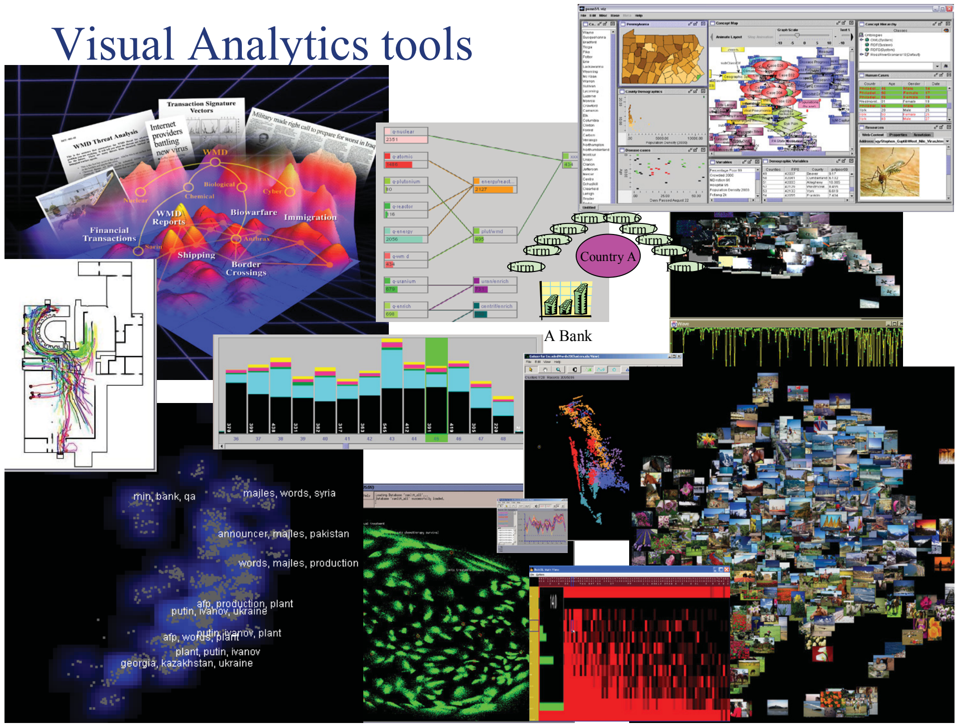


Figure 10: Some of the visualizations from some of the most common visual analytics tools, mentioned above.

3 Value Proposition

3.1 Science Town 2.0

All hazards emergency management is a complex problem space requiring expert knowledge and much practical experience in a wide range of disciplines. It also requires a methodology that can collate and organize this knowledge to support foresight and decision making (Ritchey, 2006:1). Through the advent of a coordinated employment (mobilization) of authoritative Federal expertise and capability associated with MS&A in the guise of a “Science Town 2.0”, foresight and decision support are enabled through timely, relevant and authoritative hazard knowledge and mitigation strategies.

In this support to operations concept, what emerges as essential elements of the mobilization of a “Science Town 2.0” are: valid and authoritative datasets, validated models and simulations and domain expertise. Conducting hazard, impact, and vulnerability assessments; understanding potential impacts on facilities, structures, infrastructure, populations; providing hazard information to diverse stakeholders all support the emergency management decision making process. Through exploring the ‘what if’ scenarios, better informed decision making is enabled. The improved hazard knowledge also supports hazard awareness, planning, facilitating mutual aid agreements, enduring social and institutional relationships, resource acquisition, training and education, drills and exercises.

The value MS&A can bring is significant. Formal representations of disasters are the first steps toward the development of decision support tools to be used for estimating the impact of different types of disasters and mitigating their effects both in terms of human life loses and damages to various infrastructures. This also emphasizes the requirement for disasters management and effects mitigation and the correct understanding of the interdependency and vulnerabilities to the critical portions of critical infrastructures or operations. Developing disaster plans, evacuation plans, business continuity plans, collaborative partnerships, resource sharing agreements; draw upon the hazard knowledge and understanding of interdependencies and vulnerabilities.

4 Conclusion

4.1 A Pilot project

The evidence is overwhelming nationally and internationally regarding the benefits of MS&A to support discovery, foresight, insight and decision making (Masys and Vallerand, 2011). It is noted that the USA has recently recognized Modeling & Simulation as a *National Critical Technology for the security and prosperity of the United States* (the *House Resolution 487*) (Longo, 2010: 1).

With the success of the mobilization of 'Science Town' to support Counter-Terrorism threats to safety and security of Canadians, it is proposed to extend this concept in the mobilization of a "Science Town 2.0" to support All Hazards risk, crisis and disaster management.

A pilot project is proposed to initiate the mobilization of unique and authoritative federal MS&A to support a real-time disaster management for the safety and security domain through the establishment of a public safety and security MS&A Working Group resident within the federal S&T community. This pilot effort would determine which particular authoritative experts are capable to contribute to which particular national scenarios, what authoritative tools and data sets can be mobilized, what related CONOPS can be documented and what outcomes can be thus supported.

4.2 Closing Remarks

As new threats and risks emerge, whether from terrorists, natural disasters, or human-caused accidents, emergency management planners, operators and first-responders must be equipped to respond quickly and effectively. S&T is instrumental in modeling and predicting natural disasters, such as earthquakes, tsunamis, floods, landslides, and forest fires, and helping us prepare for and respond to these events (Mobilizing S&T to Canada's Advantage, 2007: 22) including in providing key risk assessments on these type of events.

Strengthening the government's ability to execute the modeling and analyses described depends not only on the application of existing capabilities to all hazard problems, but also on the development of new capabilities. A modeling, simulation and analysis mobilization agenda through the advent of a "Science Town 2.0" would include a focus on homeland safety and security, modeling and analysis including the analysis of interdependencies among critical infrastructures, agent-based and system dynamics modeling, development of simulators and learning environments, and risk assessment and management from a multi objective perspective, including risks up to and including potentially extreme and catastrophic events. This would also fit well in a vision of stronger collaboration among federal departments towards integrated environmental modeling systems executed within fully supported 24/7 computing infrastructures.

The key principle of this paper is that Canada’s store of scientific and technological knowledge is a key resource within the all hazards domain. A key aspect in the effective deployment of any of the technologies discussed in this report is the ease and effectiveness of use of information and other technical outputs by the people they are intended to support. The nation’s capabilities for pursuing an expanded and coordinated S&T agenda for the crosscutting MS&A described in this paper are considerable. A number of programs with broad applicability to enabling a “Science Town 2.0” have already been established within CSS. The access to MS&A capabilities in reach-back mode needs to be designed to ensure long-term sustainability. A mechanism is needed for coordinating all of this work in crosscutting areas across agencies. The logical approach would be to use CSS as the coordinating body. It is suggested that CSS establish a pilot project to assess the benefits of such an extension of the mobilization of unique Federal S&T capability in MS&A in support of all Hazards disaster management.

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List of symbols/abbreviations/acronyms/initialisms

CBRNEf	Chemical, Biological, radiological, Nuclear, Explosive, Forensics
CONOPS	Concept of Operations
CSS	Centre for Security Science
DoDAF	Department of Defence Architecture Frameworks
DRDC	Defence Research and Development Canada
EC MSC	Environment Canada Meteorological Service of Canada
HILP	High Impact Low Probability
MASAS	Multi-agency Situational Awareness System
S&T	Science and Technology
R&D	Research & Development
TIC	Toxic Industrial Chemicals
TIM	Toxic Industrial Materials

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The Vancouver 2010 Olympics (V2010) and G8/G20 summits were the largest domestic security and law enforcement mobilization operation in Canadian history. The security footprint for the Vancouver 2010 Olympics theatre of operations included over 30 secure venue locations spanning 150 kilometers and covered approximately 15,000 square kilometers thereby surpassing all previous major events in scope, scale and complexity.

To support the Vancouver 2010 Olympics and G8/G20 Major Events, unique federal Chemical, Biological, Radiological, Nuclear, Explosives and Forensics (CBRNEf) capabilities were mobilized and operationalized in support of defence and security operations through the establishment of a mobile ‘Science Town’. The success of this deployment of CBRNEf capability has precipitated the development of a Concept of Operations (CONOPS) to ensure effective and efficient mobilization of such CBRNEf S&T support in the future.

Recent national and global disasters (such as flooding, earthquakes, volcanic activity, hurricane, tsunamis and other weather phenomena) have highlighted the urgent requirement to harness and mobilize additional unique Federal S&T capabilities to support All Hazards Risk Assessment and disaster management to inform public safety and security decision making in a timely fashion. Modelling, Simulation & Analysis (MS&A) are known as crucial, effective and efficient enablers for the Defence Communities and have shown themselves as a proven capability in support of the national security domain as demonstrated through Vancouver 2010 Olympics and G8/G20 Summits (Masys and Vallerand, 2011).

Through its mandate, the Centre for Security Science (CSS) is well positioned to leverage existing, unique, credible and authoritative MS&A and mobilize it to support decision making related to all hazards scenarios such as man-made and natural disasters. Such capabilities reside across the federal government, and if mobilized and operationalized (much like the CBRNEf capabilities), they could produce a broad and profound impact to support national resilience and national confidence in the safety and security domains.

This discussion paper proposes a position to enhance the support posture vis a visa multi-agency crisis and disaster management domain through the additional mobilization of unique federal MS&A capabilities. Facilitated by CSS, the MS&A capabilities and expertise that reside within unique and horizontal ‘Clusters’ and extended ‘Communities of Practice ‘across the Federal Government can be leveraged to support risk, crisis and disaster management operations thereby formalizing a reach-back capability to support decision making, across not just the counter-terrorism domain but also the All Hazards domain.

E Les Jeux olympiques de Vancouver (V2010) ainsi que les sommets du G8 et du G20 de 2010 ont mobilisé les plus importantes forces d’application de la loi et de sécurité nationale de l’histoire du Canada. L’empreinte de la sécurité du théâtre d’opérations des Jeux olympiques de Vancouver 2010 s’est retrouvée dans plus de 30 emplacements sécurisés qui s’échelonnaient sur 150 kilomètres et couvraient environ 15 000 kilomètres carrés, surpassant ainsi tous les grands événements antérieurs en matière de portée, d’envergure et de complexité.

Dans le cadre des grands événements que sont les Jeux olympiques de Vancouver (V2010) et

les sommets du G8 et du G20 de 2010, des capacités fédérales uniques relatives aux incidents chimiques, biologiques, radiologiques, nucléaires, explosifs et judiciaires (CBRNEJ) ont été mobilisées à l'appui des opérations de sécurité et de défense par la mise en place d'une « ville scientifique » mobile. La réussite du déploiement des capacités CBRNEJ a accéléré l'élaboration d'un concept d'opérations (CONOPS) visant à assurer la mobilisation efficace, à l'avenir, du soutien des S & T en matière de CBRNEJ.

De récentes catastrophes nationales et mondiales (notamment, des inondations, des tremblements de terre, de l'activité volcanique, des ouragans, des tsunamis et autres phénomènes météorologiques) ont illustré l'urgence de mettre à profit et de mobiliser des capacités fédérales uniques en matière de S & T afin d'appuyer l'évaluation tous risques et la gestion des catastrophes dans le but d'aider à la prise de décisions relatives à la sûreté et à la sécurité publiques en temps opportun. La modélisation, la simulation et l'analyse sont réputés être des outils habilitants des milieux de la Défense et se sont avérés être des capacités probantes à l'appui du domaine de la sécurité nationale, tel que démontré lors des Jeux olympiques de 2010 à Vancouver et des sommets du G8 et du G20 (Masys and Vallerand, 2011).

En vertu de son mandat, le Centre pour la sécurité des sciences (CSS) est en mesure de tirer profit d'outils existants, uniques, crédibles et spécialisés de modélisation, de simulation et d'analyse et de les mobiliser de manière à appuyer la prise de décisions relatives à tous les scénarios de risques, notamment les catastrophes causées par l'homme et les catastrophes naturelles. On trouve ces capacités à l'échelle du gouvernement fédéral. Si elles sont mobilisées et mises en service (comme dans le cas des capacités CBREFJ), elles peuvent avoir de fortes répercussions sur la résilience et la confiance nationales dans les domaines de la sûreté et de la sécurité.

Ce document de travail propose une solution visant à améliorer la posture d'appui d'un domaine de gestion de crise et de catastrophe multi organismes grâce à la mobilisation supplémentaire de capacités fédérales uniques en matière de modélisation, de simulation et d'analyse. Supervisées par le CSS, les capacités en matière de modélisation, de simulation et d'analyse et l'expertise à l'intérieur de « grappes » uniques et horizontales et de « collectivités de praticiens » élargies à l'échelle du gouvernement fédéral peuvent être utilisées pour appuyer les opérations de gestion des risques, des crises et des catastrophes, formalisant ainsi une capacité de soutien à l'appui de la prise de décisions, non seulement dans le domaine de la lutte au terrorisme, mais aussi au domaine tous risques.

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Science Town; Disaster Management; Multi-Agency CONOPS; Crisis Management: All Hazards